Palladium CTE
$\simeq 13 \times 10^{-6}/C$

US-PAT-NO: 5521432

DOCUMENT-IDENTIFIER: US 5521432 A

TITLE: Semiconductor device having improved leads comprising palladium plated nickel

DATE-ISSUED: May 28, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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ASSIGNEE INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
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APPL-NO: 08/ 252540

DATE FILED: June 1, 1994

PARENT-CASE:

This is a continuation of application Ser. No. 07/959,807, filed Oct. 13, 1992, now abandoned.

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	3-264665	October 14, 1991

INT-CL: [06] H01L023/495,H01L023/48 ,H01L023/52 ,H01L029/40

US-CL-ISSUED: 257/677, 257/766 , 257/741 , 257/768

US-CL-CURRENT: 257/677, 257/741 , 257/766 , 257/768 , 257/E23.054

FIELD-OF-SEARCH: 257/670; 257/687 ; 257/766 ; 257/741 ; 257/768 ; 257/769 ; 257/666 ; 257/677 ; 257/735 ; 257/676 ; 428/670 ; 428/680

REF-CITED:

U.S. PATENT DOCUMENTS

PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL		
4785137	November 1988	Samuels	174/52	N/A	N/A
4970569	November 1990	Mori et al.	257/677	N/A	N/A
4977442	December 1990	Suziki et al.	357/70	N/A	N/A
5032895	July 1991	Horiuchi et al.	357/72	N/A	N/A
5066550	November 1991	Horibe et al.	428/670	N/A	N/A
5175609	December 1992	DiGiacomo et al.	257/766	N/A	N/A
5221859	June 1993	Kobayashi et al.	257/676	N/A	N/A

FOREIGN PATENT DOCUMENTS

FOREIGN-PAT-NO	PUBN-DATE	COUNTRY	US-CL
3717246	November 1987	DE	257/677
2-42753	February 1990	JP	
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OTHER PUBLICATIONS

07/874,916 Jun. 16, 1986 Casey (5,264,399) IBM.

07/174,060 Mar. 28, 1988 Abbott (FNC).

07/313,769 Aug. 22, 1989 McLellan (ABN5).

ART-UNIT: 258

PRIMARY-EXAMINER: Hille; Rolf

ASSISTANT-EXAMINER: Arroyo; T. M.

ATTY-AGENT-FIRM: Staas & Halsey

ABSTRACT:

A semiconductor device includes a semiconductor chip, a die-pad on which the
semiconductor chip is mounted, a package encapsulating the die pad and the semiconductor chip, and a plurality of leads electrically connected to the semiconductor chip and projecting from the package, wherein each of the leads has a lead body made of pure nickel (Ni) having a purity equal to or greater than 99% and a first film formed thereon, the first film being made of palladium (Pd).

32 Claims, 15 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 7

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Detailed Description Text - DETX (12):

In addition, the thermal expansion coefficients of nickel (Ni) and palladium (Pd) are respectively approximately 13.times.10.sup.-6 /deg and 12.times.10.sup.-6 /deg. The thermal expansion coefficient of the resin of which the package is made is approximately 14.times.10.sup.-6 /deg. That is, the lead body 4-1, the die-pad 3-1 and the package 6 have respective, similar thermal expansion coefficients. Thus, even if the semiconductor device 1 is heated (in, for example, the molding machine), the palladium films 7 do not scale off the lead body 4-1 and the die-pad body 3-1. Moreover, the thermal stress in the package 6 is small under a condition in which the semiconductor device 1 is heated. Thus, the wires 5 and the package 6 are prevented from breaking and cracking respectively.

PZT : CTE ≃ $1.8 \times 10^{-6}/C$

US-PAT-NO: 5113204

DOCUMENT-IDENTIFIER: US 5113204 A

TITLE: Ink jet head

DATE-ISSUED: May 12, 1992

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Miyazawa; Yoshinori	Nagano	N/A	N/A	JP
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ASSIGNEE INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Seiko Epson Corporation	Tokyo	N/A	N/A	JP	03

APPL-NO: 07/ 511259

DATE FILED: April 19, 1990

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	1-99103	April 19, 1989
JP	1-99104	April 19, 1989
JP	1-133010	May 26, 1989

INT-CL: [05] B41J002/01,B41J002/045

US-CL-ISSUED: 346/140R

US-CL-CURRENT: 347/68, 347/47 , 347/88

FIELD-OF-SEARCH: 346/14PD; 346/75

REF-CITED:

U.S. PATENT DOCUMENTS

PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL		
3925791	December 1975	Hunt	346/140R	N/A	N/A
4158847	June 1979	Heinzl et al.	346/140R	N/A	N/A
4243995	January 1981	Wright et al.	346/140R	N/A	N/A
4459601	July 1984	Howkins	346/140R	N/A	N/A
4631557	December 1986	Cooke et al.	346/140R	N/A	N/A
4779099	October 1988	Lewis	346/1.1	N/A	N/A
4998120	March 1991	Koto et al.	346/140R	N/A	N/A

FOREIGN PATENT DOCUMENTS

FOREIGN-PAT-NO	PUBN-DATE	COUNTRY	US-CL
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0338590	October 1989	EP	
1418274	December 1975	GB	

OTHER PUBLICATIONS

Kiyoji Momose, "Ink Jet Recording Apparatus", Patent Abstracts of Japan, Jun. 1988, vol. 12, No. 222 (M-712) (3069).

ART-UNIT: 218

PRIMARY-EXAMINER: Fuller; Benjamin R.

ASSISTANT-EXAMINER: Bobb; Alrick

ATTY-AGENT-FIRM: Cushman, Darby & Cushman

ABSTRACT:

An ink jet head for a recording apparatus comprises: a nozzle-formed member having a plurality of nozzle orifices; a heating member for heating ink which

is solid at ambient temperature to liquefy the ink; a piezoelectric converter spaced apart from the nozzle-formed member for causing the liquefied ink to be loaded between the piezoelectric converter and the nozzle-formed member and for
jetting the liquefied ink loaded therebetween through the nozzle-formed member; and a member for relatively displaceably positioning the nozzle-formed member.

7 Claims, 10 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 5

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Detailed Description Text - DETX (11):
As is apparent from the above description, the unitization of the head with the member whose thermal expansion coefficient is different from that of the head itself causes a thermal stress due to a difference in temperature between ambient temperature and the head that is heated and maintained as heated during
the ink jetting operation. The thermal stress will be eliminated in the following manner with the above-described construction of this embodiment. Although the frame 20 made of aluminum has a large thermal expansion coefficient and the converter unit 31 a small thermal expansion coefficient, the relative positional deviation between the two members is very small. For instance, let it be supposed that a distance between the screw and the pin, i.e., the holes 44 and 45, is 40 mm; the thermal expansion coefficient of aluminum is 23E-6/.degree. C. (the term "E-6" as used herein means "10.sup.-6 "); the thermal expansion coefficient of PZT (PZT is used as the material of the converter unit 31) is 1.8E-6/.degree. C. Then, the dimensional difference caused at both ends when the temperature difference is 200.degree. C. can be calculated to be 170 .mu.m. Such a small deviation can be absorbed by the elastic deformation of the screw in this arrangement, in which the one end the converter unit .is positioned by the pin and the other is screwed. Therefore, the converter unit is neither subjected to application of excessive external forces nor deformation. In order to reduce thermal stresses within the converter unit, it is desirable that each member constituting the converter unit 31 should have a substantially equal thermal expansion coefficient. Thus, the material must be selected from this viewpoint. In this embodiment, the base material 25 is made of glass or ceramic; the piezoelectric material, PZT;

the metal layer 34, invar, which is a metal having a low thermal expansion coefficient; and the spacer 23 is likewise made of invar, so that the above requirement can be satisfied. As the permanent magnet, a sintered rare earth metal magnet, a ferrite magnet, or the like can be used as having a high coercive force at high temperatures and a proper thermal expansion coefficient. They may be bonded by a soft type bonding agent such as a silicon rubber.

Detailed Description Text - DETX (14):

FIG. 7 shows a sectional view of an ink jet head which is a still further embodiment of this invention. A cantilevered piezoelectric converter 331 is of multilayer structure with a piezoelectric material layer 331 of PZT interposed between an electrode 332 made of an Au foil and a metal layer 333 made of a foil of invar that is an alloy whose thermal expansion coefficient is substantially equal to that of PZT, and is bonded to the base 312 made of a ceramic material whose thermal expansion coefficient is substantially equal to that of PZT. A base 312 that is made of an isolating material has on its upper surface an electrode pattern 342 that is to be electrically connected. In order to connect the electrode 332 of a piezoelectric converter 311 to an external drive circuit, a wiring 343 of a flexible board that has a corresponding wiring pattern confronting with the electrode pattern 342 is bonded so that the wiring patterns and the electrode are in conduction. The electrode for maintaining each piezoelectric converter 11 at the same potential is electrically wired when the spacer 344 is bonded on the metal layer 333 surface, which is the side opposite to the electrode. Further, the base 312 is arranged on a holder 315 having a built-in heater 314 for melting the ink in the head and maintaining the temperature over the melting point. On the other hand, a nozzle-formed board 316 having a plurality of nozzles 316a fabricated by subjecting Ni to an electroforming process is secured to a center frame 317 made of a stainless material whose thermal expansion coefficient is substantially equal to that of the nozzle-formed board by means of welding.

Detailed Description Text - DETX (17):

As is apparent from the above description, thermal stresses are caused during the ink jetting operation if the head is unitized with a member whose thermal expansion coefficient is different from itself; because as the head is heated to a high temperature, there exists a temperature difference between the high temperature and the ambient temperature. The components are more likely to be deformed or broken with larger temperature differences. Particularly, the clearance between the piezoelectric converter 311 and the nozzle-formed board 316 must be highly accurate in order to ensure the prescribed ink jetting performance. For instance, according to the results of an experiment conducted

by the inventor and his group using a PZT of 0.1 mm in thickness, such a clearance must be controlled to 5 to 40 .mu.m.+-.10 .mu.m depending on the viscosity of the ink. With the arrangement of this embodiment, the thermal stresses will be relieved in the following manner. There is so small a difference in thermal expansion coefficient between the pair of the piezoelectric converter 311 and the base 312, and the pair of the nozzle-formed board 316 and the center frame 317, respectively that the thermal stresses to be caused will be small. More specifically, let it be supposed that the thermal expansion coefficient of the piezoelectric converter 311 using the value of PZT is 1.8E-6/.degree. C. (the term "E-6" as used herein means "10.sup.-6 "); and that of the base 312, using the value of ceramic, is 2E-6/.degree. C. Then, the dimensional difference caused by a temperature difference of 200.degree. C. between the piezoelectric converter 311 of 40 mm in flat plate and the base 312 is as small as 1.6 .mu.m. On the other hand, if the thermal expansion coefficient of the nozzle-formed board 316 using the value of Ni is 12.8E-6/.degree. C., and that of the center frame 317 using the value of a stainless steel is 13E-6/.degree. C., then, the dimensional difference with a temperature difference of 200.degree. C. is 1.6 .mu.m. If the piezoelectric converter 311 and the nozzle-formed board 316 are unitized, the dimensional difference caused under the same condition is 88 .mu.m, which is 50 times that of the case where the components whose thermal expansion coefficients are close to each other. Such a dimensional difference directly affects the respective components as a thermal stress. That is, the center frame 317 whose thermal expansion coefficient is large presses the base 312 so as to expand from within, resulting in deformation or breakage of either of the two. In order to absorb this dimensional difference, the center frame 317 is secured to the base 312 by interposing therebetween the screw 318 through the V-shaped plate spring 319 as shown in FIG. 8. Since the plate spring 319 is easily deformable with respect to a force in the length direction of the center frame 317, it can absorb the above-described dimensional differences caused by
differences in thermal expansion coefficient. However, the plate spring 319 is rigid in directions orthogonal to the length direction of the center frame 317; i.e., the vertical direction with FIG. 8 viewed from the front and the direction of going through the sheet on which FIG. 8 is drawn. Therefore, the clearance between the piezoelectric converter 311 and the nozzle-formed board 316 can be maintained accurately. The respective nozzles 316a disposed on the
nozzle-formed board 316 are arranged so that they coincide with the center of the respective piezoelectric converters 311 that are thermally expanded at an operating temperature.